CROSS-REFERENCE

Applicant claims priority from United Kingdom patent application _____ filed July 11, 2002.

BACKGROUND OF THE INVENTION

U.S. patent 6,439,906 describes a coaxial connector system in which a first connector has a first contact with a beam that is upwardly biased against a second contact. When a second connector, or plug, is pushed toward the first connector, a plug inner contact pushes down the beam and deflects it out of engagement with the second contact. This arrangement not only opens one circuit, between the first and second contacts, and closes another circuit, between the first contact and the plug inner contact, but enables the plug to be pushed down sufficiently for outer coaxial contacts to fully engage one another. One disadvantage of this arrangement is that there is only moderate pressure between the inner contact of a plug and the beam, which can result in high resistance between them. Also, to obtain even moderate force between the plug inner contact and the beam, the beam should be deflected considerably, which can require a longer beam or which can result in excessive stress on the beam. A connection system that minimized stress of the beam while ensuring firm engagement of the beam and plug inner contact, would be of value.

The connection system is especially useful for a mobile phone system, in which a mobile phone has a transmit/receive circuit that is initially connected to a portable antenna on the mobile phone. When the mobile phone is placed against a docking station which recharges batteries in the mobile phone, the transmit/receive circuit is disconnected from the portable antenna, and connected

to a more effective stationary antenna on the docking station. The disconnection from the portable antenna and connection to the stationary antenna, is done automatically during docking. Coaxial connectors are used to transmit high frequency signals to the docking station antenna. Other applications can require such a connector system.

SUMMARY OF THE INVENTION

In accordance with one embodiment of the present invention, a connection/switch arrangement is provided, in which a first connector in the form of a receptacle has an opening that can receive a second connector, or actuator, in the form of a plug. When the plug is received, an inner contact of the plug contacts and downwardly deflects a beam until the plug is fully installed in the receptacle. The present system minimizes deflection of the beam and assures high pressure contact between the plug inner contact and beam. A stop lying under the beam, limits downward deflection of the beam, which assures high contact pressure with small beam deflection. The plug inner contact can slide upward with respect to the plug frame against the resilience of a spring. Accordingly, when the plug is pushed down, the plug inner contact depresses the beam against the stop, and the plug frame can continue to move down slightly while the plug inner contact is stopped.

The receptacle connector is mounted on a circuit board. The stop can be formed by the circuit board.

The novel features of the invention are set forth with particularity in the appended claims. The invention will be best understood from the following description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an exploded isometric view of a connector/switch assembly of the prior art.

Fig. 2 is an exploded view of a connector/switch arrangement of the present invention, with the receptacle, or first connector shown in section view and shown mounted on a circuit board.

Fig. 3 is a sectional view of the connector/switch arrangement of Fig. 2, with the connectors fully engaged with each other.

Fig. 3A is a partial sectional view of a connector/switch arrangement of another embodiment of the invention.

Fig. 4 is a partial isometric view of the first and second contacts of the connector/switch arrangement of Figs. 2 and 3.

Fig. 5 is an exploded isometric view of a mobile phone and a portion of a docking station, which includes the connection/switching system of Figs. 2, 3 and 4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 shows a prior art connector assembly, which includes a first connector/switch or receptacle A, which is usually mounted on a circuit board, and a second connector or plug B. The receptacle has first and second contacts C, E,

with the first contact having a beam G that is normally engaged with the second contact E. A projection H projects upwardly from a location on the beam G. When the plug B is pushed down into an entrance J of the receptacle, an inner contact K of the plug engages the upward projection H on the beam, and downwardly deflects the projection and beam. Such downward deflection continues until an outer contact M of the plug engages an outer contact P of the receptacle. It is difficult to assure high pressure contact between the plug inner contact K and projection H.

Fig. 2 illustrates a connection arrangement 10 of the present invention, which includes a first connector 12 that also operates as a switch and which can be referred to as a receptacle, that is mounted on a circuit board 14. The particular receptacle 12 has first and second contacts 14, 16 mounted on an insulative housing 20. The housing has an entrance or opening 18 in its top 19, the opening leading to a cavity 17 that receives the first and second contacts. The contacts have tails connected to conductive traces 22, 24 on the upper face of the circuit board 28, as by solder connections. The receptacle has an outer contact 26 which is also mounted on the insulative housing, and which is connected to a circuit trace that is grounded.

A second or plug connector, or actuator 30, is designed to mate with the receptacle 12 by moving down the plug 30, in the direction D when the receptacle is in the orientation shown. The plug includes inner and outer plug contacts 32, 34 mounted on an insulative plug frame 36. The particular plug is a coaxial plug, in which case the plug inner contact lies within the outer contact, but the plug inner contact is not necessarily a coax inner contact. The receptacle outer contact 26 is not truly a coax contact.

The first contact 14 of the receptacle includes a beam 40 that is biased upwardly against the second contact 16. In a mobile phone, the first contact 14 may be connected to a transmit/receive circuit on the mobile phone, while the second contact 24 is connected to a portable antenna on the mobile phone. When the plug 30 is pushed downward against the receptacle, the plug inner contact 32 engages and downwardly deflects the beam 40, so the beam 40 moves out of engagement with the first contact 16. At the same time, the plug inner contact 32 has made engagement with the beam 40 so they are electrically connected. In the above example, the plug 30 is part of a docking station for a mobile phone, and the plug inner contact 32 is connected to a docking station antenna which provides better reception and transmission than the portable antenna on the local phone. When the plug contact 32 engages the deflectable beam 40, the transmit/receive circuit that is connected to the first contact 14 is connected to the docking station antenna, and is disconnected from the second contact 16 that leads to the mobile antenna.

Fig. 3 shows the plug and receptacle in a fully mated position. The plug inner contact 32 has downwardly deflected the beam 40 of the first contact 14, so the first contact 14 is out of engagement with the second contact 16, and the first contact 14 is engaged with the plug inner contact 32. At the same time, the plug outer contact 34 has engaged the receptacle outer contact 26. In the particular connector illustrated, the plug outer contact 34 has a resiliently-deflectable projection 50 that enters a fixed groove 52 in the receptacle outer contact, to not only cause the outer contacts to engage each other, but to latch the connectors together and provide a "click" for tactile feedback. As shown in Fig. 2, the plug outer contact has slots 54 that divide a sheet metal plug outer contact into a plurality of tines 56 that can be resiliently deflected apart and then resiliently press inwardly.

In order to assure that the plug 30 can be pressed down far enough for the plug outer contact projection 50 to fully enter the receptacle outer contact groove 52, the plug inner contact 32 is able to accommodate different heights of the plug frame 36 and plug outer contact 34. Previously, this was accomplished by relying solely on deflection of the receptacle first contact beam 40 by varying amounts. The present invention does not require varying amounts of beam deflection.

The plug inner contact 32 is moveably mounted in the plug frame so a lower part 60 of the plug inner contact can move upwardly with respect to the plug frame 36. This is accomplished by mounting the lower part 60 of the plug inner contact so it is vertically slideable and is biased downwardly by a spring 62. In Fig. 3, the lower part 60 has tines 64 that engage an upper part 66 of the plug inner contact. It is also possible to carry current through the spring, although this can add inductance, and is usually not desirable for high frequencies.

Applicant uses an area 70 of the circuit board as a stop that limits downward movement of the beam 40. The stop 70 ensures firm engagement of a tip 68 of the contact lower part 60 with the beam, despite only a small downward movement of the beam. This allows the use of a thinner and more resilient sheet metal beam and enables the use of a receptacle of smaller height. In addition, this arrangement assures firm contact of the plug inner contact part with the beam, with the force being controlled primarily by the pre-load of the spring 62.

Applicant prefers to provide the circuit board with a conductive trace 72 on the circuit board substrate 72, the trace lying under an engaging part of the beam 74. The trace 72 is connected to trace 22. This allows currents to flow directly between the plug inner contact and a circuit board trace that connects to the

receive/transmit circuit, to flow directly through the engaging part of the beam 74, instead of through the curved rest of the first contact, to minimize inductance.

Fig. 4 shows some details of the first and second contacts 14, 16. Both contacts are formed of sheet metal, with the first contact forming a bend at 80, an overmolded mounted part at 82 that is molded to the receptacle housing, and the beam 40. The beam extends forwardly F from the mounted part. The beam includes a wide forward part 90 with a hole 84 forming a tongue 92. The tongue 92 has a part 94 that extends rearwardly R and downward D, and that forms the engaging part 74. The tongue inclined part 94 locates the engaging part 74 under the wide part 90 near the front of the beam.

Fig. 5 shows a transceiver in the form of a mobile phone 100 with a transmit/receive circuit 102 that is normally connected to a portable mobile phone antenna 104. The receptacle 12 lies in the mobile phone. A docking station 110 which can receive the mobile phone, forms the plug 30 that connects to the receptacle 12 when the mobile phone is placed on the docking station. A docking station antenna 112 which is more efficient than the mobile phone antenna 104 is connected to the circuit 102 when the mobile phone is docked.

Fig. 3A illustrates another arrangement, in which the housing 20A of a connector 12A forms a lower wall 120 that forms a stop 122 that stops downward deflection of the beam part 74A.

While applicant has used terms such as "down" and "up" to describe operation of the apparatus as illustrated in the drawings, it should be understood that the connectors can be used in any orientation with respect to the Earth.

Thus, the invention provides a connector/switch system, or connection arrangement, which is especially useful for connecting coaxial connectors and switching a first contact of the receptacle connector out of engagement with a second contact of the receptacle when an inner contact of a plug engages the first contact of the receptacle. The first contact includes a downwardly-deflectable beam which is preferably integral with the rest of the first contact and which is downwardly deflected by the plug inner contact of the receptacle. A stop is provided which stops downward movement of the beam after it has deflected downward by a small distance out of engagement with the second contact. The plug inner contact includes a downwardly-biased slideable part that allows a frame of the plug to move down slightly further after the plug inner contact part has been stopped from further downward movement when it presses the beam against the stop. The stop can be formed by a circuit board on which the receptacle is mounted.

The novel features of the invention are set forth with particularity in the appended claims. The invention will be best understood from the following description when read in conjunction with the accompanying drawings.